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Goddard Space Flight Center
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Tropical Rainfall Measuring Mission

From Rain Gauges to Radar: A History of Rainfall Measurement

People have been measuring rainfall amounts for more than 2000 years, but we still don't know how much rain falls in remote areas of the globe. For the first time, we will be able to directly measure global rainfall rates with the Tropical Rainfall Measuring Mission (TRMM).

Floods and droughts have been making history since the beginning of civilization. Rainfall, however, also is associated with the less catastrophic uncertainties that affect us all. Farmers know that "you have to make hay when the sun shines." If farmers want to harvest their hay, it must be dry, and they sometimes work all day and all night to bring in their crops if rain is in the forecast. In the larger economic picture, not only the farmers, but economists and financial traders monitor rainfall to see if there will be healthy crops. If production is abundant, prices will probably drop and investors can plan their investments accordingly.

In addition to agriculture, measuring rainfall is important in other ways. Hydrologists monitor rainfall to predict river flows and flood stages, as well as the storage of water in lakes and reservoirs. During heavy rain periods, hydrologists use rainfall data from stations upstream to predict flood stages downstream. Another increasingly important use of rainfall information is to program it into global weather and climate models to improve forecasts of changes in our weather and climate. Significant improvements in these forecasts will occur as our ability to measure rainfall around the world improves.

Traditionally, taking rainfall measurements has been a simple matter of setting out rain gauges. Around 350 BC, the Indian author, Kautilya, described the first known rain gauge in his manuscript, Arthasastra. Described as a 20 inch diameter bowl, measurements were taken regularly as a way of estimating the annual crop to be sown. The Chinese reported the first known use of rain gauges in the year 1247 AD during the Southern Song Dynasty.

If you want to measure the amount of rain where you live, you can simply set out a rain gauge and collect the rain that is falling near your house. Simple and inexpensive rain gauges will let you measure rain amounts to the nearest 1/100th of an inch. Researchers that need to measure the rainfall for an entire area will set out a network of rain gauges, collect the data and map out the results. This tedious task is adequate for specialized projects, but does not work well when trying to map out rainfall for the entire world. The advent of weather radar changed this problem/situation considerably. Today, a single weather radar can map out rainfall in a circle that may have a diameter of 250 miles (400 kilometers).

Until now, measuring rainfall across the world has been a tough proposition. Temperatures and pressures have been much easier to measure because they vary continuously from one area to another. If we measure the temperatures at two places one mile apart, it is reasonable to expect that the temperature half way between the two places will have a value that is not very different from the temperatures at the two places you measured. The same can be said for pressure. Scientists say that atmospheric temperatures and pressures are *continuous* variables; however, when it comes to rainfall, things are different. It can be raining heavily at two places that are one mile apart while no rain is falling at a place that is halfway between. Rainfall is an unusual *discontinuous* atmospheric phenomenon.

The discontinuity of rainfall makes it very difficult to measure. Yet, rainfall is a part of the hydrologic cycle that sustains life on Earth, and it is critical to the world's populations. Rainfall provides water for our food and drinking supply, energy needs (e.g. dams and geothermal energy), transportation needs, and more. Furthermore, the weather that we are experiencing right now, regardless of where a person lives, is related to the amount of rainfall that falls between the latitudes of 23.5°N and 23.5°S, a region known as the tropics . It is well known that the atmosphere gets three-fourths of its weather-producing energy from the heat process associated with rainfall. Since the majority of Earth's rain falls in the tropics, tropical rainfall has a direct link to global weather patterns. Furthermore, weather extremes such as drought and floods are directly influenced by the frequency and consistency of tropical rainfall.

Although weather radar technology enables us to map rainfall over land, it is not likely to be found in less developed countries or in sparsely populated areas of the world due to its expense, nor is it capable of measuring rainfall over the oceans. Weather radars do exist on some islands and ships, but the coverage is much less than adequate. To address this problem, the United States Department of Defense has established a constellation of polar orbiting satellites that carry Special Sensor Microwave/Imager (SSM/I) instruments. These sensors are called "passive detectors" because they are able to simply receive microwave energy that is emitted naturally from the Earth below. Variations in the amount of energy received at different frequencies can be interpreted in terms of the rate at which the rain is falling near the ground while the satellite is overhead.

The joint U.S.-Japanese Tropical Rainfall Measuring Mission (TRMM) will provide the next advancement in global measurement of rain from space. The TRMM satellite will carry an improved passive microwave detector similar to the SSM/I, but for the first time will have an "active" spaceborne weather radar called the Precipitation Radar (PR). Similar to weather radars on the ground, the PR will emit pulses of electromagnetic energy and measure the energy reflected from precipitation in the atmosphere below, as it orbits the Earth. The PR will be able to detect a raindrop's size, speed, and altitude. "Seeing" a raindrop with TRMM will be like detecting an automobile approximately 200 miles away with a police traffic radar gun (which on average can detect automobiles at distances of approximately 800 ft). Having both passive and active sensors on this spaceborne observatory will lead to greatly improved results in the measurement of precipitation. The end result should be the most comprehensive set of quantitative tropical rainfall data in history.

Visit the TRMM Homepage at
http://trmm.gsfc.nasa.gov